Space Weather Technical Forecast

Issued on Tuesday, 24 January 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Reducing risk of R1/R2 Radio Blackouts and G1/Minor Geomagnetic Storms after midweek (UTC).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been at Low levels during the past 24 hours, with numerous C-class flares observed and a number of these were attributed to a region now approaching the far southwest limb, namely AR3194. There are currently nine sunspot regions on the visible disc, and two unnumbered with one in the extreme northeast and the other in the extreme northwest. AR3190 retains a Mt Wilson Delta spot, and the leading group has seen further minor areal growth and penumbral development. AR3191, AR3192 and AR3200 have overall seen a decrease in growth whereas AR3197 has shown some growth in intermediate and trailing spots. There are currently numerous filaments on the solar disc, with most of these concentrated near the western solar limb in both hemispheres, which is of note as they could be triggered by the more active sunspots here should they flare appropriately. Coronagraph imagery in the period showed numerous small CMEs emerging from the west and southwest and none of these have been assessed as having an Earth-directed component. After 23/0500UTC, a southeast-directed CME appeared with a possible halo shock, which is considered to be far-sided and off the Sun-Earth line. No new Earth-directed CMEs were therefore in evidence at the time of writing.

Solar Wind / Geomagnetic Activity: Solar winds, as measured at L1 by ACE and DSCOVR showed a relatively noisy trace with Slightly Elevated to Elevated levels, and are currently steady at around 575 km/s. These were suggestive of an initial waning fast wind, probably that from CH68/+, which then saw a small discontinuity at 23/0300UTC at L1 which may suggest influence of one of the expected CMEs, perhaps most likely that from 19 January.
The solar wind density was slightly above average in low double figures. The IMF showed the most noteworthy behaviour in the 24 hours, with the 0300UTC discontinuity most marked here, rising from near 6nT to 11nT, while the north-south component varied between -8 and +11nT. The Bz component was mainly co-aligned with the Earth's field to limit geomagnetic impacts (thus far), while the phi angle was chaotic and variable in nature before settling by 23/15500UTC to positive (away from the Sun). The net effect of the above solar wind measures was Quiet to Unsettled, with a provisional peak Kp of '3o' in the 12-15UTC interval.
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 has been at Background levels throughout.
High energy electron flux (greater than 2 MeV) has been at Normal Background to Moderate levels. The 24-hour integrated electron fluence stayed well below the Active threshold on a slowly increasing trend, with 9.36e6 integrated pfu observed at 23/2100UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with the most potent regions in the southwest. These should rotate off the disc after midweek UTC to slightly reduce the daily chances of M-class activity.

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Solar Wind / Geomagnetic Activity: The geomagnetic forecast is of lower than average confidence for the period: both due to marginal influence of a number of CMEs before midweek, and also a non-persistent coronal hole. Initial Likely Minor Storm G1 conditions should become less prevalent as the week progresses (barring significant developments), especially as the filaments and more-active southwest quadrant spots rotate away from the Sun-Earth line.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES16 is likely to remain at predominantly Background levels, but with a Slight Chance of reaching S1 or greater through the period.
Electron flux should remain at Normal Background to Moderate levels, as at present, although this carries low confidence due to a number of CMEs and a non-persistent coronal hole fast wind due in the period. The greatest likelihood of surpassing Active fluence should arrive after midweek UTC and the expected fast wind, with the effect on electrons rated as an eventual Chance of Active fluence at peak.

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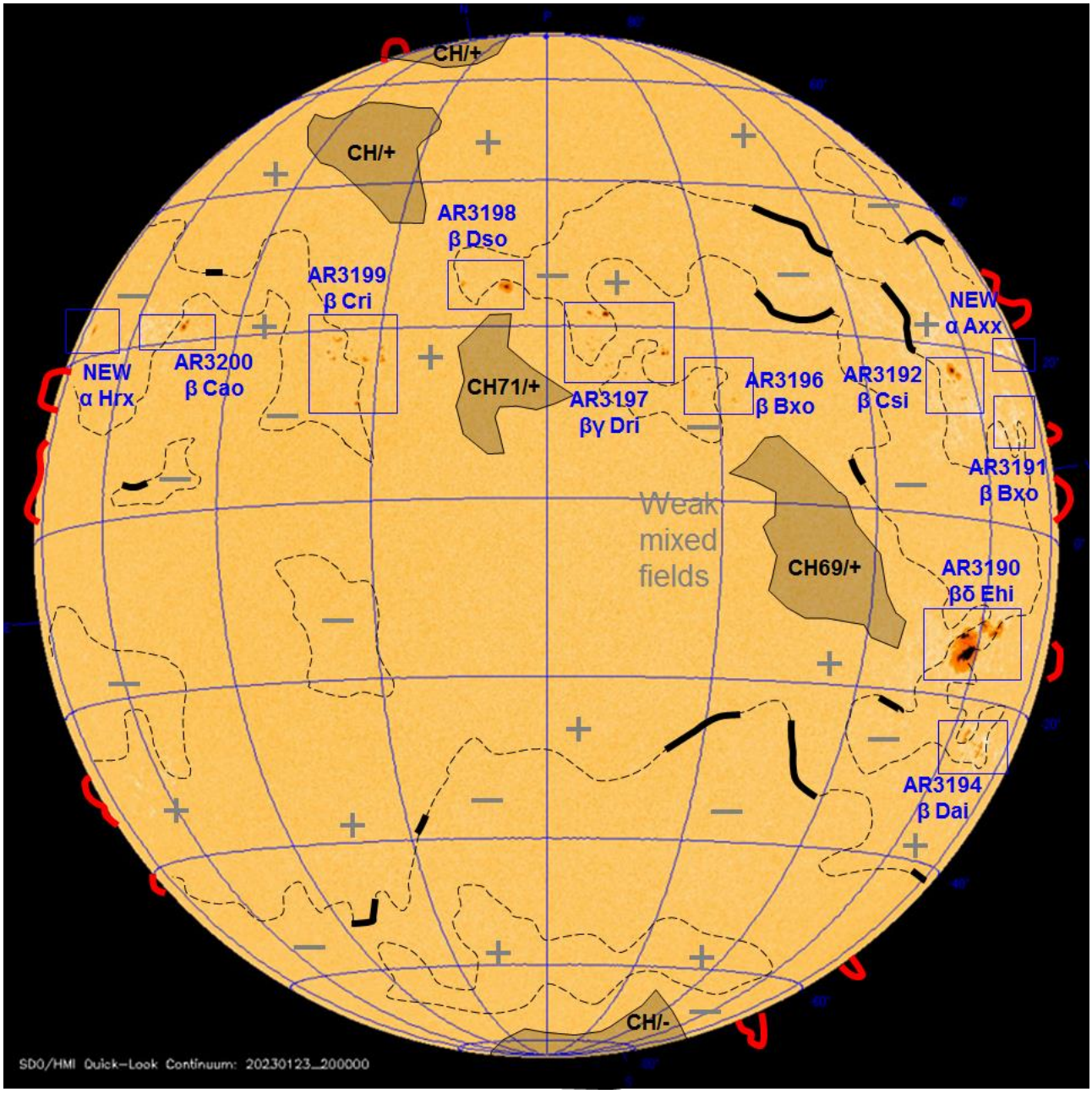
Figure 1. Solar Analysis Valid 2000 UTC, 23 January 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast continues to have lower than average confidence as a consequence of potentially Earth directed CMEs along with a non-persistent coronal hole (CH69/+) currently mooted for Day 1 (24 January), and a further coronal hole (CH71/+) that may have some effects on 27 or 28 January.

The roster of possible CMEs includes a faint emission from 19 January and up to two further events from 20 January, with these final two mainly directed below the ecliptic plane. Any or all of the above could arrive as a united front, although this is perhaps more likely with the latter two CMEs rather than the former. There is some evidence of a discontinuity in the solar wind as of 23/0300UTC, especially visible in IMF, which may be related to the first of the above events, although this is conjectural, and the event has thus far been very slight in terms of impacts.

Earth is otherwise now exiting the influence of the recent fast wind from CH68/+, with a brief hiatus now expected before a likely more potent fast wind perhaps arrives from equatorial CH69/+, most likely arriving later on Tuesday 24 January, or perhaps early on 25 January. The positive polarity of this feature should perhaps serve to slightly mitigate its potency given our gradual approach to the vernal equinox.

All considered, the risk of Minor Storm G1 intervals comprises a well-spread low peak through the first half of the UTC working week as a consequence of all of the above, with Thursday 26 January perhaps the most reliably Quiet day should no further CMEs materialize.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	20	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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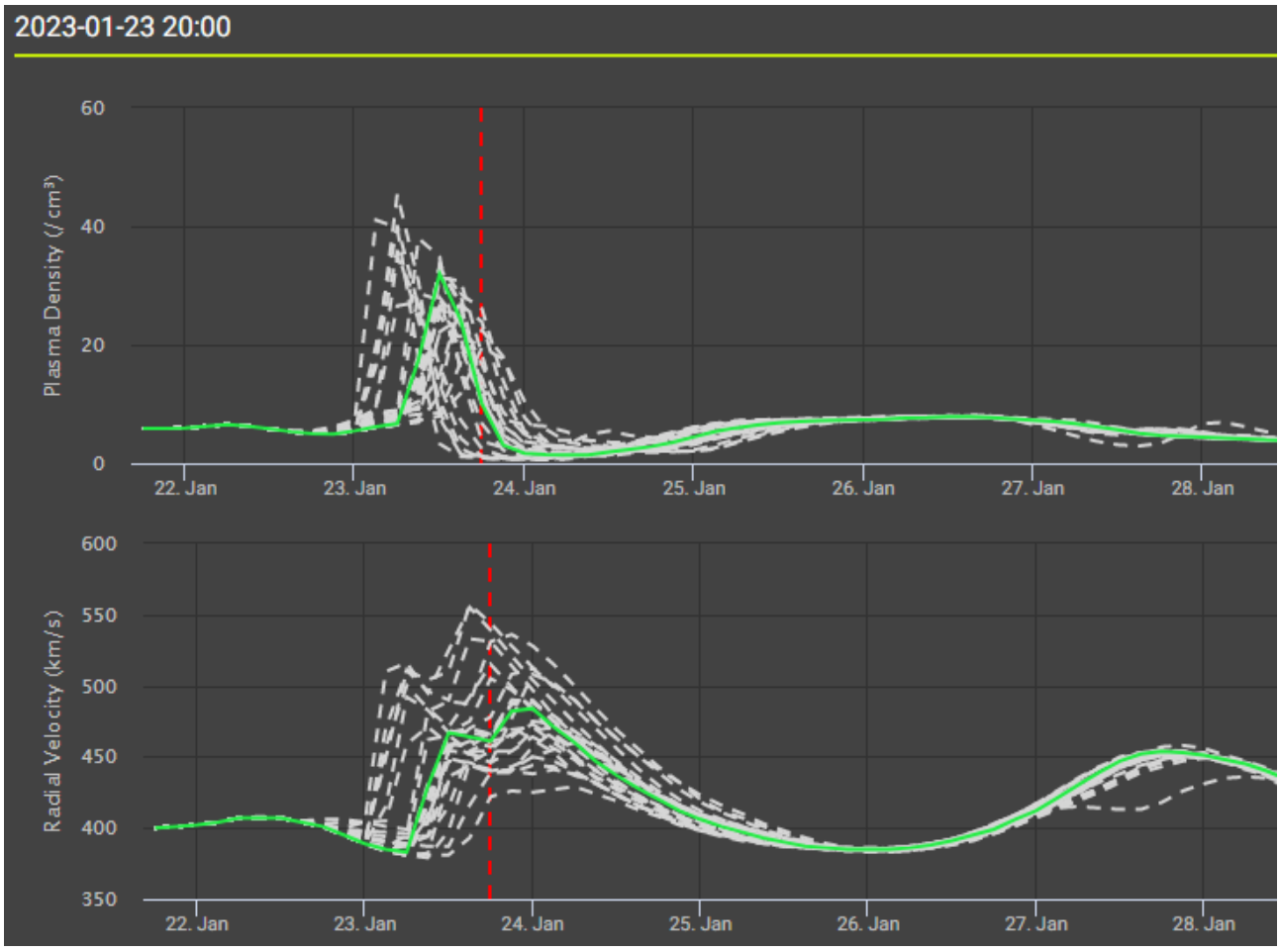
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/1847	Partial	Filament Eruption	SW	770km/s	23/1200UTC	Possible glancing blow. Medium confidence.
20/2222	Partial	Flare	AR3190 (SW)	450km/s	24/1800UTC	Possible glancing blow, low confidence.

Figure 2: Latest Met Office ENLIL output with likely arrival times at Earth for incoming CMEs.



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Radio Blackouts - X-Ray Flares:
Solar activity has been Low in the past 24 hours, and Low to Moderate levels of solar activity are envisaged to continue until at least midweek UTC, whereupon the departure of the largest and most active sunspot group may serve to slightly reduce the risk of further M-class flares. Far-side soundings and returning Carrington locations continue to hint that arrivals are to be expected over the eastern limb in the period, although these will be assessed as and when they present for analysis. Meanwhile, of greater certainty, both of the current more-active groups (AR3190 and AR3194) should leave the disc after midweek, which has the effect of slightly reducing the risk of flares by Thursday 26 January.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	40	40
Very Active	R3 to R5 X Class	No	5	5	1	1

Figure 3: GOES X-ray flux in the past 24 hours depicting numerous C-class flares.

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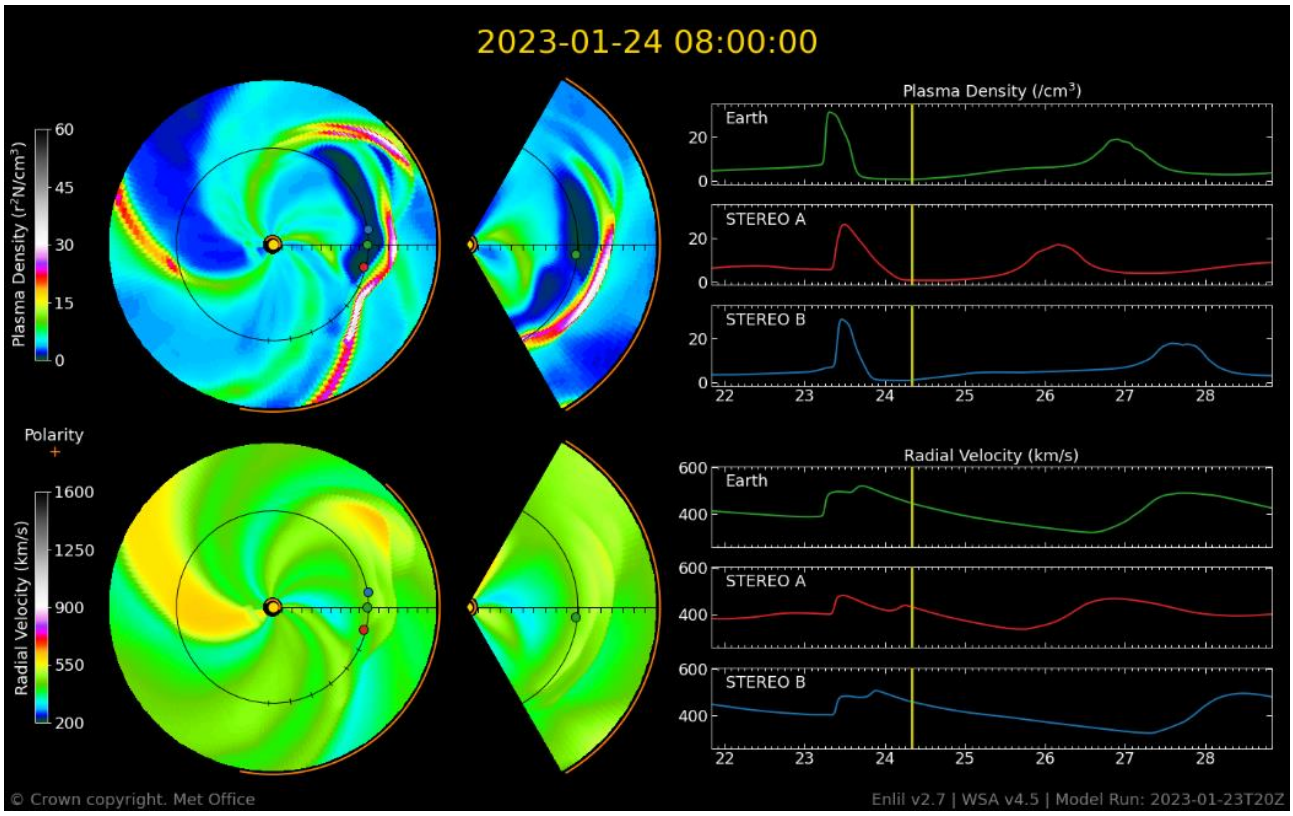
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux is currently at Background levels and this will probably continue although the large Active Region 3190 will pose the greatest risk of a response to S1 levels or greater in coming days, even once it rotates out of view, across the southwestern limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Latest ENLIL output showing the probable CME that impacted early on 23 Jan.



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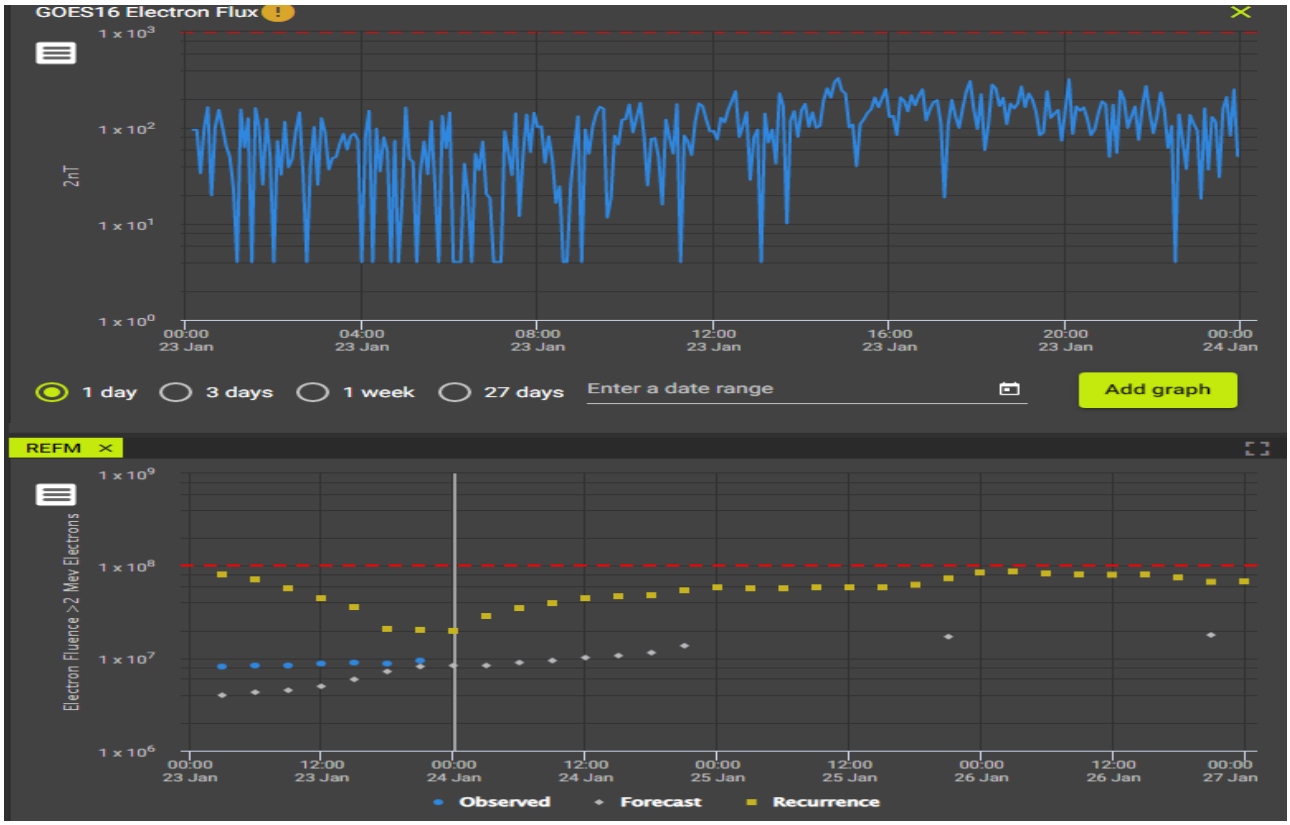
High Energy Electrons Event (≥ 2MeV):

Electron flux should remain at Normal Background to Moderate levels, as per its current diurnal oscillation given expected geomagnetic activity from a number of low confidence transients. The main risk to Active electron fluence being realised in the four days is the expected onset of CH69, which is mooted for 24 January. Because this is a newly-developed feature on this pass, confidence as to its effects and magnitude are both currently low, with the threat of CMEs early in the forecast also serving to reduce confidence further still. Of greater confidence is the fact that the latest available STEREO A MAG and PLASTIC data does suggest that any fast wind remains at least 24 hours away. The effects from the aforementioned fast wind should wane soon after midweek UTC, which ought to provide the peak risk of exceedence for the period as a whole, although this currently remains a Chance given the inherent uncertainties involved.

MOSWOC REFM is not considered particularly useful guidance at present given the relative dominance of non-persistent features in the forecast and continues to over-forecast the fluence levels, however it suggests levels below Active throughout the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	40	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	5

Figure 5: High energy electron flux at GEO and Met Office REFM output.



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